

VARIABLE RESOLUTION DECODER

BACKGROUND OF THE INVENTION

1. Field of the Invention:

5 The present invention relates to a decoder for decoding image data compressed with a compression method such as MPEG-2 supporting interlaced scanning, and more particularly to a variable resolution decoder for decoding image data such that the image data has lowered resolution at the time of display.

2. Description of the Related Art:

10 In reproducing image data compressed with a compression method such as MPEG-2 which is known as a standard for realizing functions of compression and decompression of moving images and voice in real time, the image data is displayed on a display with resolution different from the size of the image data in some cases.

15 An example of such cases is when an image from an HDTV (High Definition Television) is output on a typical TV monitor or when image data is displayed on a monitor of a personal computer (hereinafter referred to as "PC"). In such a case, it is common practice to completely decode image data and then reduce the image data at the time of display, in which case detailed portions of the image (high-frequency components) are lost through the reduction processing. For this reason, image data is decoded with

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its high-frequency components removed in advance and the image data is reduced at the time of decoding, thereby improving reproduction performance. When image data is decoded with software on a PC, reproduction of image data of resolution lowered during decoding can lighten load on its CPU required for decoding the image data even when the CPU has low performance.

A decoder which lowers resolution of image data during decoding to output the reduced image data has been proposed in a document "Scalable decoder with no low-frequency drift" (Iwahashi, Kambayashi, and Kiya: Technical Report of IEICE DSP94-108 1995-01). Fig. 1 shows the decoder. For decoding compressed image data, only low-frequency components of discrete cosine transformed (hereinafter abbreviated as "DCT") blocks are used to perform inverse discrete cosine transform (hereinafter abbreviated as "IDCT") on 4 by 4 pixel blocks for lowering resolution. Motion compensation is performed by reducing values of decoded motion vectors to half with quarter image accuracy.

In the method, however, field information of image data of alternate lines is lost by reduction processing in a vertical direction in interlaced scanning. Thus, a problem occurs that field prediction employed in MPEG-2 or the like is not accurately made.

To solve the problem, Japanese Patent Laid-open

Publication No. 2000-059793 proposes a method in which IDCT is performed in different manners for a field DCT mode and a frame DCT mode. In the method, for the frame DCT mode in which a top field and a bottom field are
5 subjected together to DCT, image data is separated into two fields by once performing IDCT, field DCT is applied to each field, and only low-frequency components thereof are used to perform IDCT, thereby achieving reduction processing with field information maintained. The method
10 involves an increased amount of operations and thus is not suitable for a field requiring high processing performance such as decoding of image data with software on a PC. It can be said that the method is not appropriate at all for a case in which display resolution is lowered in order to
15 improve reproduction performance.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a variable resolution decoder for obtaining reduced image
20 data with its field information maintained at fast speed and with a simple configuration.

A variable resolution decoder of the present invention decodes image data compressed with a compression method such as MPEG-2 supporting interlaced scanning, and
25 includes means for performing variable length decoding and inverse quantization on the compressed image data, means

for checking a discrete cosine transform mode of a frame
and performing inverse discrete cosine transform in 4 by 8
pixels when the mode is a discrete cosine transform mode,
and means for acquiring image data of full resolution for
5 interlaced scanning in a vertical direction and thinning
interlaced scanned image data to perform image reduction
processing during decoding with field information
maintained.

According to another aspect, a variable resolution
10 decoder of the present invention decodes image data
compressed with a compression method such as MPEG-2
supporting interlaced scanning, and includes means for
performing variable length decoding and inverse
quantization on the compressed image data, means for
15 checking a discrete cosine transform mode of a frame and
performing reduction processing in a discrete cosine
transform area for resolution of interlaced scanning in a
horizontal direction, and means for performing reduction
processing in a pixel area for resolution of interlaced
20 scanning in a vertical direction.

The means for performing reduction processing in the
discrete cosine transform area is field inverse discrete
cosine transform processing means for performing inverse
discrete cosine transform processing in a field discrete
25 cosine transform mode, and the means for performing
reduction processing in the pixel area is frame inverse

discrete cosine transform processing means for performing
inverse discrete cosine transform processing in a frame
discrete cosine transform mode.

According to another aspect, a variable resolution

5 decoder of the present invention decodes image data
compressed with a compression method such as MPEG-2
supporting interlaced scanning, and includes means for
performing variable length decoding and inverse
quantization on the compressed image data, means for
10 selecting a discrete cosine transform mode, means for
checking a discrete cosine transform mode of a frame and
performing inverse discrete cosine transform in 4 by 8
pixels when the mode is a frame discrete cosine transform
mode, and means for acquiring image data of full
15 resolution for interlaced scanning in a vertical direction
and thinning interlaced scanned image data, wherein the
image data is decoded such that the image has lowered
resolution at the time of display.

According to another aspect, a variable resolution

20 decoder of the present invention decodes image data
compressed with a compression method such as MPEG-2
supporting interlaced scanning, and includes means for
performing variable length decoding and inverse
quantization on the compressed image data, means for
25 checking a discrete cosine transform mode of a frame and
performing inverse discrete cosine transform in 4 by 8

pixels when the mode is a discrete cosine transform mode,
and means for acquiring image data of full resolution for
interlaced scanning in a vertical direction and thinning
interlaced scanned image data, wherein the image data is
5 decoded such that the image has lowered resolution at the
time of display.

10 The means for thinning image data takes only even-
numbered lines of the interlaced scanned image data and
calculates the averages of two adjacent taken lines which
are used as data of top field, and takes only odd-numbers
lines of the interlaced scanned image data and calculates
the averages of two adjacent taken lines which are used as
data of bottom field to decode the image data at halved
resolution both vertically and horizontally with field
15 information maintained.

The present invention includes means for decoding
image data compressed with a compression method such as
MPEG-2 supporting interlaced scanning such that the image
has lowered resolution at the time of display by
20 performing IDCT in 4 by 8 pixels in a frame DCT mode and
acquiring image data of full resolution before thinning of
the image in a vertical direction.

25 In Fig. 2, a variable resolution decoder of the
present invention comprises storage device 1 for storing
compressed original image 11, image data processor 2 for
decoding image data loaded from storage device 1, and

display 3 for displaying the decoded image data.

When compressed image data is decoded with lowered resolution (downscale decoding), simple IDCT with a lower order results in loss of field information, and thus field prediction employed in a compression method is not performed accurately. To address the problem, according to the present invention, IDCT is performed in different manners for a field DCT mode and a frame DCT mode which are employed in a compression method to enable lowered resolution with field information maintained. The compression method herein refers to already standardized one such as MPEG 2.

Since the method of the present invention can decode image data without requiring complicated processing, it is effective particularly for decoding of image data by software.

A first effect of the present invention is the ability to realize downscale decoding with no degradation of picture quality.

This is because different processing is performed depending on DCT modes to enable lowered resolution with field information maintained.

A second effect of the present invention is the ability to realize downscale decoding at fast speed.

This is because the decoding process does not rely on IDCT in 8 by 8 pixels which involves a large amount of

operations.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram showing a configuration of
5 a prior art;

Fig. 2 is a block diagram showing a configuration of
a first embodiment of the present invention;

Fig. 3 illustrates a frame DCT mode in which DCT is
performed with 8 by 8 pixels;

10 Fig. 4 illustrates a field DCT mode in which DCT is
performed on each field obtained by arranging alternate
lines in a macro block of 16 by 16 pixels;

Fig. 5 illustrates IDCT performed with 4 by 8 pixels
and thinning to half in a vertical direction for lowering
15 resolution;

Fig. 6 is a flow chart illustrating the operation of
the first embodiment of the present invention;

Fig. 7 is a block diagram showing a configuration of
a second embodiment of the present invention; and

20 Fig. 8 is a flow chart illustrating the operation of
the second embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Next, preferred embodiments of the present invention
25 are described in detail with reference to the drawings.

Referring to Fig. 2, a configuration of a first

embodiment comprises storage device 1 for storing compressed image data, image data processor 2 operating under control of a program, and display 3 for displaying image data.

5 Storage device 1 includes original image 11 compressed with a compression method such as MPEG-2 supporting interlaced scanning.

10 Image data processor 2 comprises compressed data buffer 21 for holding image data loaded from storage device 1, variable length decoding and inverse quantization section 22 for performing variable length decoding and inverse quantization which is a first step of decoding, DCT mode selecting section 23 for selecting a DCT mode, field IDCT section 24 for performing IDCT in a field DCT mode, frame IDCT section 25 for performing IDCT in a frame DCT mode, vertical thinning section 26 for performing thinning for interlaced scanning in a vertical direction in the frame DCT mode, low resolution MC section 27 for performing motion compensation on image data of lowered resolution, and frame data buffer 28 for storing image data to be displayed.

 Image data decoded in image data processor 2 is displayed by display 3.

25 Next, the operation in the embodiment is described in detail with reference to Figs. 2 to 6.

 In Fig. 2, storage device 1 stores original image 11

compressed with a compression method such as MPEG-2 supporting interlaced scanning.

For decoding the compressed image data, compressed original image 11 is first loaded into compressed data
5 buffer 21. Original image 11 is assumed to be compressed with a compression method such as MPEG-2 supporting interlaced scanning, and the decoding of the image data is performed through a procedure of variable length decoding, inverse quantization, IDCT, and motion compensation. At a
10 first step of the decoding, variable length decoding and inverse quantization section 22 performs variable length decoding and inverse quantization on the data of original image 11. The result of the inverse quantization is discrete cosine transformed data in 8 by 8 pixel blocks.

15 A frame DCT mode refers to a mode in which DCT is performed using 8 by 8 pixels in a frame with no change as shown in Fig. 3. On the other hand, a field DCT mode refers to a mode in which DCT is performed on each field obtained by arranging alternate lines in a macro block of
20 16 by 16 pixels as shown in Fig. 4.

For lowering resolution of image data at the decoding, IDCT is typically performed with a lower order than DCT in 8 by 8 pixels performed at the time of coding. For example, when resolution is reduced to half both
25 horizontally and vertically, IDCT is performed in 4 by 4 pixels. In the frame DCT mode, however, the IDCT in 4 by

4 pixels results in loss of field information. In this case, motion compensation after the IDCT is not performed accurately and thus accurate decoding results cannot be obtained. For this reason, DCT mode selecting section 23
5 detects the DCT mode of an image to perform processing in the frame DCT mode different from processing in the field DCT mode. In the field DCT mode, since data of a block is configured for each field, field IDCT section 24 performs IDCT in 4 by 4 pixels to lower resolution. In the frame
10 DCT mode, IDCT is performed to lower resolution only in the horizontal direction irrelevant to fields. Specifically, frame IDCT section 25 performs IDCT in 4 by 8 pixels. Then, vertical thinning section 26 thins the lines in the vertical direction to half to lower
15 resolution. The thinning is performed as shown in Fig. 5 by taking only even-numbered lines and then calculating the averages of two adjacent taken lines which are used as data of a top field. Also, only odd-numbers lines are taken, and the averages of two adjacent taken lines are
20 calculated and used as data of a bottom field. In this manner, the image data is decoded at halved resolution both vertically and horizontally with its field information maintained. Motion compensation is performed in low resolution MC section 27 with halved motion vectors
25 and quarter pixel accuracy.

The decoding result is stored in frame data buffer

28 and then displayed by display 3.

Fig. 6 is a flow chart illustrating the processing for the moving image reproduction described in Fig. 2. The flow of the processing is as follows:

5 Decoding is started.

Original image 11 in Fig. 2 is transferred to compressed data buffer 21 to store image data therein (S101).

10 Variable length decoding and inverse quantization section 22 performs variable length decoding and inverse quantization on the data (S102).

DCT mode selecting section 23 checks the DCT mode of a frame (S103).

15 When the frame is in the field DCT mode, field IDCT section 24 performs IDCT in 4 by 4 pixels and the processing continues to S107 (S104).

When the frame is in the frame DCT mode, frame IDCT section 25 performs IDCT in 4 by 8 pixels (S105).

20 Vertical thinning section 26 lowers resolution in the vertical direction (S106).

Low resolution MC section 27 performs motion compensation (S107).

The image data for which decoding has been completed is stored in frame buffer 28 (S108).

25 The decoded image is displayed by display 3 (S109).

When display is not completed, the processing

returns to S101 for decoding data of the next picture
(S110).

When display is completed, the processing is
terminated.

5 Next, another embodiment of the present invention is
described.

10 In the method of the present invention, resolution
is lowered in different manners depending on DCT modes.
In the method, a difference may occur between the field
DCT mode and the frame DCT mode in position information of
pixel data on space after the lowering of resolution, and
the difference may serve as an error to affect picture
quality. To avoid this, resolution is lowered in the
field DCT mode in the same manner as the frame DCT mode to
15 eliminate the difference in position information, thereby
making it possible to suppress degradation of picture
quality. Since resolution is lowered in different manners
for the vertical direction and horizontal direction in
this case similarly to the first embodiment, the lowered
20 resolution can be achieved with field information
maintained to obtain accurate image of low resolution.

25 A configuration of the embodiment is as shown in
Fig. 7. Fig. 7 comprises, as in Fig. 2, storage device 1
for storing compressed image data, image data processor 2
operating under control of a program, and display 3 for
displaying image data. Storage device 1 stores original

image 11 compressed with a compression method such as
MPEG-2 supporting interlaced scanning. For reproducing
the compressed image, the image data is first loaded into
compressed data buffer 21. Next, as a first step for
5 decoding, variable length decoding and inverse
quantization section 22 performs variable length decoding
and inverse quantization on the data of original image 11.
The result of the inverse quantization is cosine
transformed data in 8 by 8 pixel blocks. The IDCT is
10 performed in the same manner both in the frame DCT mode
and the field DCT mode. To prevent loss of field
information, the IDCT is performed in the aforementioned
manner employed in the frame DCT mode in the first
embodiment (that is, the IDCT in 4 by 8 pixels performed
15 before thinning in the vertical direction). IDCT section
23-1 performs IDCT in 4 by 8 pixels. Then, vertical
thinning section 26 thins the lines to half vertically to
lower resolution. In this manner, decoding is performed
at the resolution halved vertically and horizontally with
20 the field information maintained. Low resolution MC
section 27 performs motion compensation. The decoding
result is stored in frame data buffer 28 and displayed by
display 3.

In this manner, resolution is lowered in different
25 manners for the vertical direction and horizontal
direction to enable lowered resolution with field

information maintained. Since IDCT in 8 by 8 pixels is not employed, decoding performance can be improved.

Fig. 8 is a flow chart illustrating the processing for the reduced display described in Fig. 7. The flow of the processing is as follows:

Decoding is started.

Original image 11 in Fig. 7 is transferred to compressed data buffer 21 to store image data therein (S201).

Variable length decoding and inverse quantization section 22 performs variable length decoding and inverse quantization on the data (S202).

IDCT section 23-1 performs IDCT in 4 by 8 pixels (S203).

Vertical thinning section 26 lowers resolution in the vertical direction (S204).

Low resolution MC section 27 performs motion compensation (S205).

The image data for which decoding has been completed is stored in frame buffer 28 (S206).

The decoded image is displayed by display 3 (S207).

When display is not completed, the processing returns to S201 for decoding data of the next picture (S208).

When display is completed, the processing is terminated.